2019 Annual Report

POPULATION DYNAMICS AND SEASONAL MOVEMENTS OF TRANSLOCATED AND RESIDENT GREATER SAGE-GROUSE (CENTROCERCUS UROPHASIANUS), SHEEPROCK SAGE-GROUSE MANAGEMENT AREA

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Cooperators

Utah Department of Natural Resources, Watershed Restoration Initiative

Utah Division of Wildlife Resources

Utah Public Lands Policy Coordination Office

US Bureau of Land Management

US Forest Service

US Geological Survey

West Desert Adaptive Resources Management Local Working Group

Utah State University Extension

Jack H. Berryman Institute

Utah Public Lands Initiative

Yamaha Outdoor Access Initiative

December 2019

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Executive Summary

Utah's 2019 Conservation Plan for Greater Sage-grouse (*Centrocercus urophasianus*; sage-grouse) reaffirmed the conservation goals of maintaining sage-grouse populations and their habitats in designated sage-grouse management areas (SGMAs; Utah Public Lands Policy Coordination Office [PLPCO 2019]). In support of this goal, we have completed four years of sage-grouse translocations to augment the recorded long-term population declines in the Sheeprock SGMA. The translocations were conducted as part of an intensive program, which included habitat and predation management. In 2019, around 20 male sage-grouse were counted on the four active leks, but snow prevented access until late season. Nest initiation rates and success rates were the highest ever reported in this population. In 2019, we recorded 17 of 24 nests successfully hatching. Five broods survived to the 50-day, post-hatch survey. In 2020, we will continue monitoring marked individuals and mark additional resident grouse. We will not translocate additional sage-grouse in 2020. We also will collect additional feather samples for analysis to determine how the translocations may have altered resident population genetic diversity.

Introduction

The estimated range-wide distribution and populations of sage-grouse have declined considerably compared to pre-settlement as well as recent estimates (Schroeder et al. 2004, Aldridge 2008, Garton et al. 2011). The prime factors contributing to the declines have been the loss and fragmentation of sagebrush habitat associated with the life history of the sage-grouse in addition to fire and invasive species (Aldridge et al. 2008, Miller et al. 2011).

Due to the range-wide population declines, the U.S. Fish and Wildlife Service (USFWS) has received multiple petitions to provide the sage-grouse protection under the Endangered Species Act (ESA). In 2010, the USFWS designated the sage-grouse as a candidate species for ESA protection (USFWS 2015). In September 2015, the USFWS reversed the 2010 decision when it announced that listing sage-grouse for ESA protection was unwarranted. The USFWS made this decision after evaluating on-going range-wide efforts by federal, state, and local partners and determined these actions had mitigated the threats to the species and provided for increased conservation certainty. In 2020, the USFWS will revisit this decision and assess the current needs of the species.

The Bureau of Land Management (BLM), the U.S. Forest Service (USFS), and the western states with sage-grouse populations and habitats, had initiated land-use planning amendments and other actions designed to mitigate the identified threats, protect important sagebrush habitats, and develop adequate regulatory mechanisms to eliminate the need for a listing under the ESA. The USFWS requests annual updates from federal, state, and local partners regarding conservation plan implementation and population status. This information will be used by the USFWS to complete the status review in 2020. The USFWS has emphasized the need to focus conservation efforts on protecting and enhancing the priority habitats as the essential mechanism for species conservation (USFWS 2013).

In response to USFWS guidance, the BLM and USFS revised their management plans for monitoring and managing sage-grouse populations on public land (BLM 2015). In Appendix B of the BLM's adaptive management plan, they outlined a series of hard and soft population triggers as part of an integrated conservation strategy. The soft triggers designated population threshold levels which would require increased consultation with state partners (BLM 2015). The hard triggers were population thresholds that require immediate actions to protect the populations (BLM 2015).

Short-term Decline:

a) 4 consecutive years of 20% or greater annual decline in average males per lek
b) average males per lek, based on lek trends, drops 75% below the 10-year rolling average in any single year

Long- term Decline

c) Population growth rate is decreasing for 6 consecutive years
d) Population growth rate is decreasing for 8 years in a 10-year window

Utah sage-grouse populations

Utah's sage-grouse populations contribute 6-8% of the range-wide populations, and are discontinuous due to topographical features of Utah's landscape (Dahlgren et al. 2016, PLPCO 2019). Population cycles vary from 9-12 years between peaks and troughs (Garton et al. 2011).

In 2019, Utah released their sage-grouse conservation plan that updated its goals developed in 2013. The plan supported sustaining the eleven Sage-Grouse Management Areas (SGMAs, Figure 1) within the state of Utah, which represent the highest sage-grouse breeding density areas and support more than 90% of the combined Utah population of sage-grouse (Dahlgren et al. 2015, PLPCO 2019). The plan also identified two primary objectives with subsequent strategies to meet those objectives. The objectives identified include efforts to:

1) Maintain and increase sage-grouse populations statewide and within each SGMA.
    a. Monitor sage-grouse population trends annually. If necessary, implement adaptive management strategies to support viable and stable populations.
2) Maintain, protect, and increase sage-grouse seasonal habitats within SGMAs through the following actions:
    a. Identify highest-priority sage-grouse habitats and migration corridors
        i. Protect at least 5,000 acres of these habitats annually
    b. Improve and increase sage-grouse seasonal habitats by 75,000 acres annually
    c. Coordinate with local, state, and federal fire-fighting jurisdictions to include sage-grouse habitats as a priority during pre-fire planning and suppression

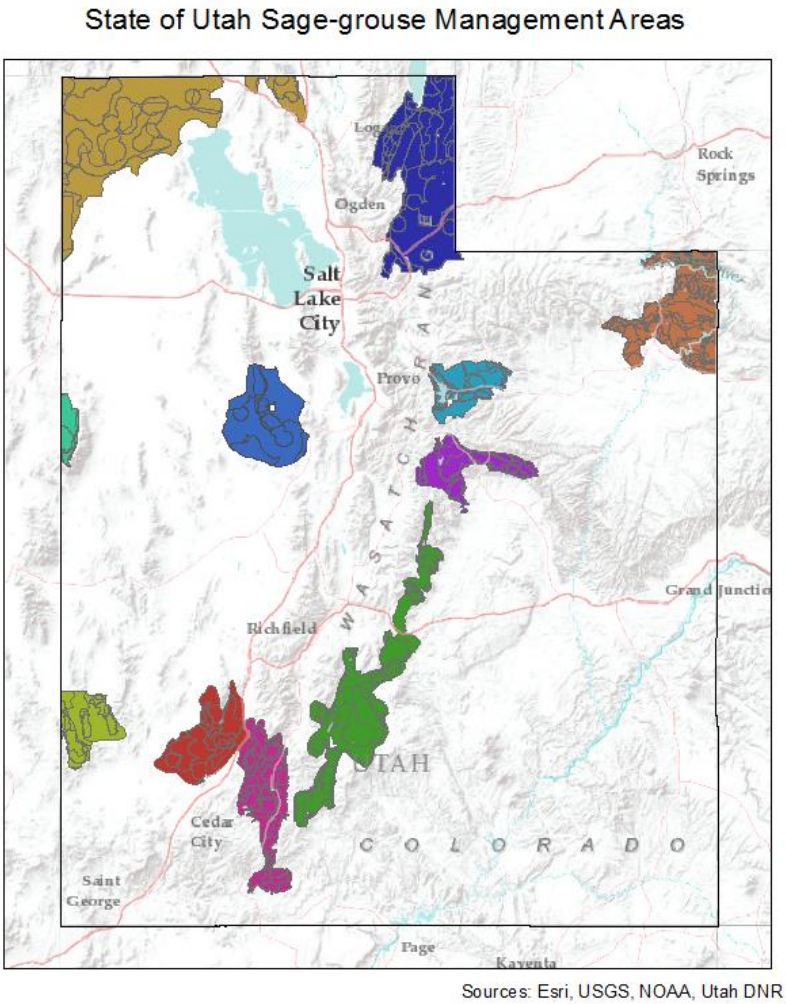

Figure 1. Utah's 11 Sage-grouse Management Areas, Salt Lake City, Utah, 2019 (PLPCO 2019).

West Desert Adaptive Resource Management Local Working Group

The West Desert Adaptive Resource Management (WDARM) local working group encompasses the Sheeprock SGMA (WDARM 2007). The WDARM (2007) identified conservation strategies to mitigate the declines in the Sheeprock sage-grouse population. These strategies included evaluating population trends, identifying research needs and knowledge gaps, determining population and habitat needs for the future, and identifying threats that have potential to affect sage-grouse in the West Desert (WDARM 2007). The strategies included:

1. Incorporate management strategies from state and federal agency partners, local governments, and established range-wide conservation and management guidelines (Connelly et al. 2004, Dahlgren et al. 2019).
2. Increase effective communication with all potential stakeholders in the West Desert and the state of Utah, through outreach, information distribution, and education
3. Address and prioritize threats to aid in prioritizing management solutions

During the normal population cycles, all 11 Utah SGMA's showed gradual declines in their populations (Garton et al. 2011). However, the Sheeprock SGMA population has continued to decline while others showed increasing population levels. Figure 2 illustrates the active male lek counts for the Sheeprocks in 2006, when 190 males were observed across the SGMA (Robinson 2007). In 2015, the number of active males counted on leks was 23 (UDWR, unpublished data).

Given these trends, the population unofficially hit the hard trigger outlined in the BLM Adaptive Management Plan (BLM 2015). During 2015, the WDARM met and discussed avenues for immediate action required to prevent extirpation of the Sheeprock population including: translocations, predator control, habitat restoration, and a long-term research project to study the population. In 2017, the BLM officially stated that the Sheeprock population reached the hard triggers outlined above. As a result, they have outlined adaptive management strategies to prevent future declines: prioritizing habitat restoration efforts, making the area the focal point for fire suppression, and seeking to minimize impacts from rights-of-way developments (BLM 2017).

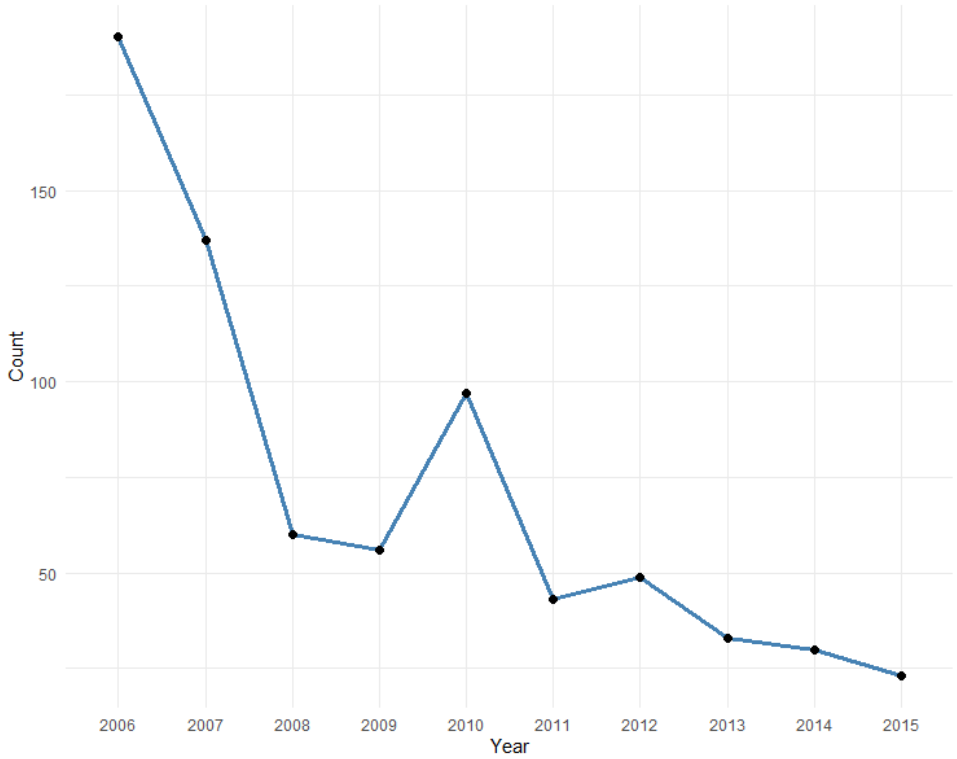

Figure 2. Average number of strutting greater sage-grouse (*Centrocercus urophasianus*) males in the Sheeprock Sage-Grouse Management Area from 2006 to 2015, Utah (Utah Division of Wildlife Resources, unpublished data).

Translocations have been used to augment, reintroduce, introduce, or genetically rescue populations of various species with the ultimate goal being to create self-sustaining populations (Griffin et al. 1989, Dickens et al. 2009). Success of translocations is contingent upon the

methods and protocol of capture, among other variables. Wild and native game bird species have been reported to exhibit the highest success rate for translocations (Griffin et al. 1989). The quality of habitat will also influence the success, with higher quality habitats leading to increased success; however, in areas with lower quality habitat, ongoing habitat restoration projects aid in success (Dickens et al. 2009). In areas where predation was implicated as a factor in the population declines, predator control has increased success (Baxter 2008). Translocating sage-grouse overnight during the breeding season and releasing them on an active lek the morning of capture has also increased survival rates of translocated individuals (Reese and Connelly 1997, Baxter 2008).

Study Purpose

The purpose of this study is to evaluate if translocations could augment the population of sage-grouse located within the Sheeprock SGMA. The specific objectives of this study are to:

1. Estimate vital rates for marked birds and determine if they differ between radio-marked translocated and resident sage-grouse.

2. Determine if the translocations increase population growth rate in years 2 and 3.

3. Evaluate seasonal habitat-use (breeding, winter), responses to habitat management actions, seasonal movements and travel corridors for marked birds, and if these variables differ between radio-marked translocated sage-grouse and resident sage-grouse.

    a. Develop specific disturbance and habitat management recommendations for the USFS, BLM, and other partners based on marked sage-grouse vital rates and habitat-use patterns. These recommendations will include the prioritization and placement of habitat restoration projects to increase mesic habitats, usable space, development and placement of migration corridors, and actions to mitigate the potential effects of dispersed recreation on sage-grouse seasonal habitats.

4. Determine predator occupancy across the study area and if it affects sage-grouse habitat selection.

5. Quantify off-highway vehicle (OHV) recreation abundance throughout the Sheeprock SGMA and determine if it affects sage-grouse habitat selection or reproductive success.

Study Area

The Sheeprock SGMA is located near Vernon, Utah in central Utah's West Desert. It is an area comprised of 611,129 acres located in both Tooele and Juab counties. The BLM and the USFS manage 325,280 and 92,328 acres of the SGMA, respectively. The remaining acres are divided as follows: private ownership (82,740 acres), Utah School and Institutional Trust Lands (SITLA; 34,131acres), and the Utah Department of Natural Resources (UDNR; 684 acres).

This area is characterized by warm, dry summers and cool winters. The 50-year average maximum summer temperature is 32.4 ˚C in July, and the minimum winter temperature is -10.4 ˚C in January (Figure 3). The average annual precipitation is 10.24 inches, with the highest amount being in the spring and fall months (Figure. 4). Average snowfall is 36.2 inches (Western Regional Climate Center 2016).

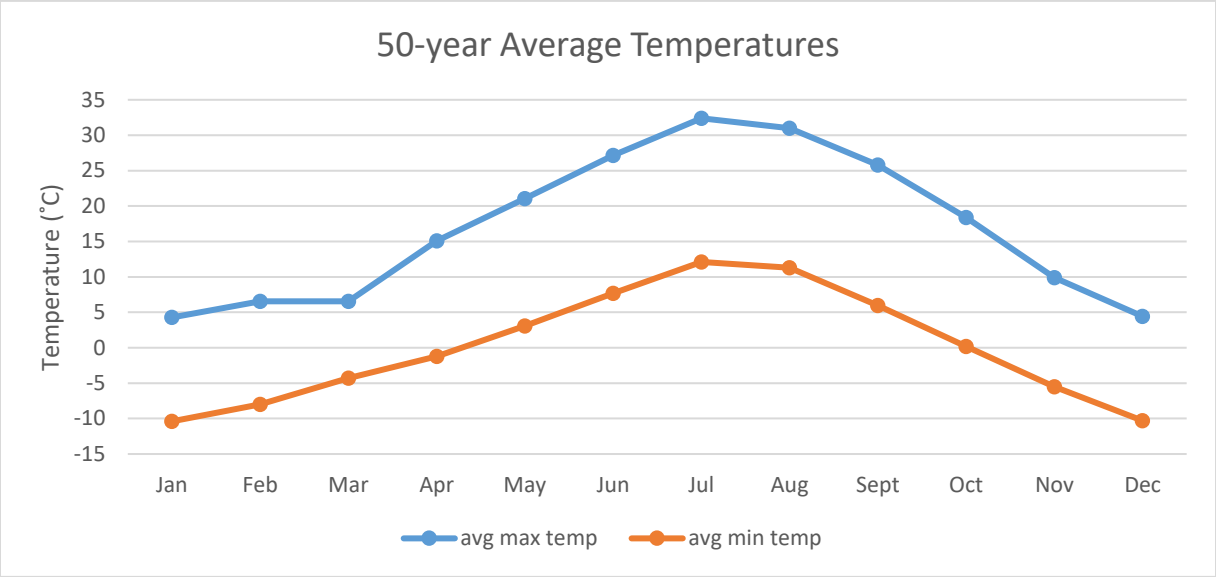

Figure 3. The 50-year average minimum and maximum temperatures per month in degrees Celsius for the Sheeprock Sage-Grouse Management Area as collected by Western Regional Climate Center in Vernon, Utah (Western Regional Climate Center 2016).

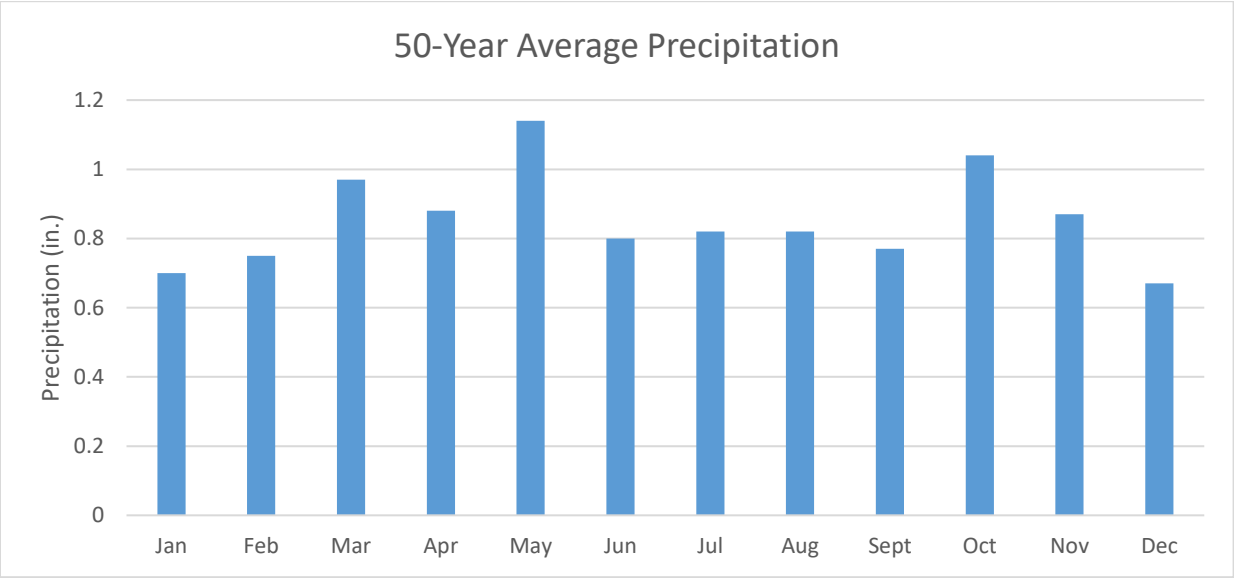

Figure 4. Average annual precipitation in inches in the Sheeprock Sage-grouse Management Area. This figure illustrates a bimodal distribution with peaks occurring during the spring and fall months (Western Regional Climate Center 2016).

Elevation ranges from 1500m in the lower valleys to 2950m at the tallest peaks. The lower elevation vegetation is comprised of Wyoming big sagebrush (*A. tridentata* spp *wyomingensis*), crested wheatgrass (*Agropyron cristatum*), and bulbous bluegrass (*Poa bulbosa;* Robinson 2007). Invasive vegetation located in the lower elevation includes cheatgrass (*Bromus tectorum*) and knapweed (*Centaurea* spp.; Robinson 2007). As elevation increases, shrubs such as the following become more prevalent: serviceberry (*Amelanchier alnifolia*), common snowberry (*Symphoricarpos albus*), antelope bitterbrush (*Purshia tridentata*), mountain big sagebrush (*A. t. vaseyana*), and juniper (*Juniperus* spp.) stands (Robinson 2007). Higher elevations, along ridgelines, are dominated by black (*A. nova*) and low sagebrush (*A. arbuscula*; Robinson 2007). Rubber rabbitbrush (*Ericameria nauseosa*) and Douglas rabbitbrush (*Chrysothamnus viscidiflorus*) are also prevalent in lower and mid elevations (Robinson 2007).

Source Capture Areas

Parker Mountain (PM) is part of Utah's Parker Mountain-Emery SGMA (Figure 5) located in south-central Utah and contains one of the largest sage-grouse populations in the state. It is located within the Great Basin Desert and characterized by mostly black sagebrush on the ridges and slopes and big sagebrush in the drainages (Baxter et al. 2008). Elevation ranges from 2,140 m to 3,000 m (Chi 2004, Baxter et al. 2008). Average annual precipitation is 567 mm with the highest precipitation in fall, winter, and spring as is characteristic of cold deserts (Dulfon 2016).

Park Valley (PV) is located in northwestern Utah in the Box Elder SGMA (Figure 5). It contains predominately big sagebrush and black and low sagebrush similar to that of the Sheeprock SGMA (Sanford et al. 2017). It is on the edge of the Snake River plain and the Great Basin Desert. Elevation ranges from 1,350 m to 2,950 m with average annual precipitation ranging from 177 mm to 783 mm from low elevation to high elevation, respectively (Sanford et al. 2017).

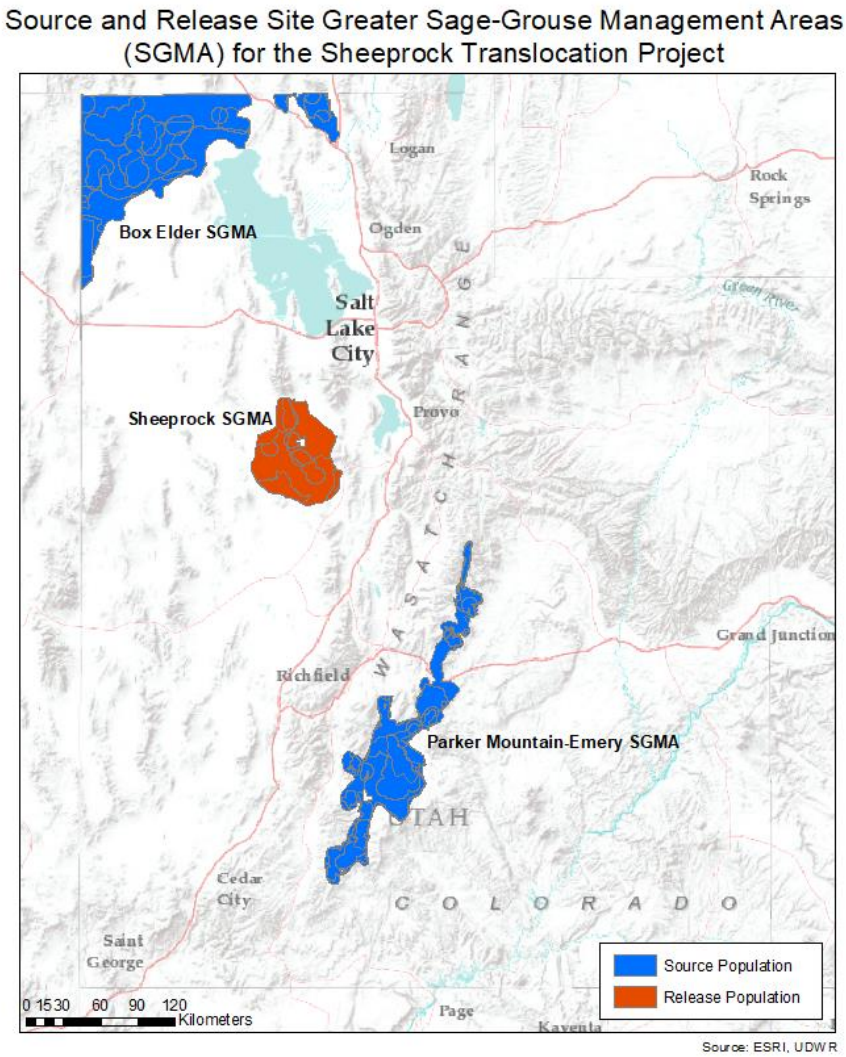

Figure 5. The release site and source populations identified for the Sheeprock Sage-Grouse Management Area (SGMA) translocations to augment the greater sage-grouse (Centrocercus urophasianus) population, Sheeprock Sage-Grouse Management Area, Utah. The sage-grouse are translocated from both Park Valley, located in the Box Elder SGMA, and Parker Mountain, located in the Parker Mountain-Emery SGMA. Resident sage-grouse within the Sheeprock SGMA are also monitored.

Methods

Translocations

Translocation methods followed guidelines outlined by Connelly et al. (1997) and Baxter et al. (2008). We have performed translocations from 2016-2019. During the lekking period, 30 females and 10 males were translocated annually from genetically compatible populations of sage-grouse located in Park Valley and on Parker Mountain (Reese and Connelly 1997, Oyler-McCance et al. 2005). Source populations were greater than 50km away from the Sheeprock SGMA, where the birds are released (Reese and Connelly 1997, Oyler-McCance et al. 2005).

Park Valley and Parker Mountain source populations were approved by the Regional Advisory Councils, the Wildlife Board, the Resource Development Coordination Council (RDCC), the Utah State University Institutional Animal Care and Use Committee (IACUC), and the West Desert, Parker Mountain and West Box Elder SGMA local working groups.

Sage-grouse were captured at night using all-terrain vehicles, spotlights, and long handled nets near active leks (2100hr to 0200hr; Connelly et al. 2003). Sage-grouse were brought to the trucks and processed—i.e. fitted with transmitters, weighed, aged, etc.—there before leaving the capture site. Most of the females and males were fitted with an 18-gram necklace-style very high frequency (VHF) radio transmitter (Advanced Telemetry systems, Insanti, MN and American Wildlife Enterprises, Monticello, FL). Some females and males were fitted with camouflaged solar-powered GPS satellite transmitters mounted on the rump of the grouse. The GPS transmitters included Ultra High Frequency (UHF) capabilities to allow for relocating marked birds in the field. Processing included mounting the transmitter, ageing, sexing, weighing, leg banding, and recording the capture locations (UTM, 12N, NAD 83).

Beginning in 2017, we collaborated with two other sage-grouse translocation studies in North Dakota and California on improving translocation protocols to improve post-release survival of translocated individuals. Under the new protocol, birds were placed in wooden remote-release boxes that contained 5 individual compartments with ventilation and transported overnight (0200hr -0530hr) in a pickup truck to the release site. At sunrise (0600hr-0630hr), radio-marked sage-grouse were released the morning following capture, within 200m of an active lek site. The remote-release boxes were lined up with the opening facing the lek, and grouse were released after the immediate area was scanned for predators.

In the Sheeprock SGMA, up to 10 resident sage-grouse (8 females and 2 males) were captured annually. Some individuals, both male and female, were marked with GPS transmitters, with the remaining individuals were fitted with the VHF radio-collars. All sage-grouse were weighed and aged, with age being determined by characteristics of the P9 and P10 wing feathers. The birds were immediately released following processing. With the Sheeprock SGMA population being so low, radio-marking 10 grouse represented a realistic goal (Robinson and Messmer 2013). Data gathered from radio-marked sage-grouse provided information on the habitat use and seasonal movements of the resident population.

Feathers were collected from both resident and translocated grouse during processing for genetic analysis. Clean feathers lost incidentally during the capture were collected; if clean feathers were not present or no feathers were lost during the capture, feathers were plucked from the breast. Feather samples were placed in small paper envelopes, sealed, and labeled with the date, sex, collector's name, bird ID, and the UTM coordinates. Samples were stored in desiccant for tissue preservation.

Lek Counts

Lek counts were conducted according to the procedures outlined in the UDWR protocol. A minimum of three counts were completed at weekly intervals beginning in mid-March and

ending May 7. The counts began 30 minutes before sunrise and end 1 hour and 30 minutes after sunrise, counting 3 to 5 times during that time period and recording the maximum number of males that visited the lek. To record whether translocated males visit the lek, the observer used radio telemetry equipment to listen for the translocated males' frequencies. Radio-marked translocated males were excluded from population calculations based on their lek attendance during lek counts within the same year they were translocated. This provided an unbiased count for the years when translocated males were released during the lekking period.

Radio-telemetry

To monitor sage-grouse vital rates and habitat-use, locations were recorded for all radio-marked grouse using UTM's in NAD83. For the VHF transmitters, birds were located with VHF receivers and VHF antennas. The data for the GPS-marked birds has a duty cycle of 5 days, so data were uploaded at the end of each duty cycle. Five to six locations were recorded per day for the GPS transmitters at different times depending on the season. For each location for VHF-marked individuals, the date, time, observer, UTM, group size, flocking with resident birds, habitat type, nearest disturbance, and survival status were recorded. Mortality for the VHF radio-collared birds was determined by a mortality signal (faster pulse rate), which initiated after the collar has remained in the same location for 8 or more hours. Mortality for the GPS transmitters was determined using the online data, which detected a mortality mode after several fixes at the same location. After a mortality signal was detected, the observer located the transmitter and determined the cause of mortality, if possible.

During the nesting season, all radio-marked females were located 2 to 3 times per week to determine the date of nest initiation. Once a nest was confirmed by visually seeing a female on a nest without flushing her, the site checked 2 to 3 times a week from 30-50 m away to determine the fate. When the eggs hatched and the hen and brood left the nest area, the clutch size was estimated by counting the number of egg shells. If a nest failed, the observer attempted to identify the cause and the female was again monitored 2 to 3 times a week to document re-nesting attempts. Broods were located 3 times a week until the brood reached 50 days old. Females that did not have broods were located 1 to 2 times per week.

During the fall and winter, collared sage-grouse were located bi-monthly using ground telemetry. Periodic flights in a fixed-wing aircraft were also used to locate grouse that were undetectable from the ground. Locations of the GPS birds were downloaded after each 5-day duty cycle to determine movement corridors and fall and winter ranges. All research activities were completed in accordance with Utah State University IACUC approved protocol.

Vegetation Surveys

For each nest and one location weekly per brood (up to 50 days of age post-hatch or failure for the brood), vegetation measurements were recorded using a line intercept method to determine shrub cover, height and species (Connelly et al. 2003). Each location consisted of four, 15m transects for nest sites and four, 10m transects for brood sites. A random compass bearing was used to determine the direction of the initial transect. Daubenmire frames (20 x 50 cm) were read

every 3m for nests and 2.5m for broods along each transect to determine the percent cover of forbs and grasses at each site (Daubenmire 1959). A Robel pole was used at each vegetation plot to assess visual obstruction, which is assessed at 4m along each transect at 100 cm high, looking both into and out from the Robel pole (Robel 1970).

Predator Surveys

Predator surveys were initiated in 2017 and will be conducted through 2020 concurrent with predator control efforts by U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Wildlife Services. These surveys were used to develop an index of the predator species abundance and how it may have changed in response to predator control in the Sheeprock SGMA. We will estimate predator occupancy across the SGMA by species. These predator survey methods were adapted from methods developed in Rich County, Utah (Dettenmaier and Messmer 2013).

Avian predator surveys

We documented avian predator abundance weekly beginning in May through July from points located on scat transects. Counts included ravens (*Corvus corax*), black-billed magpies (*Pica hudsonia*), golden eagles (*Aquila chrysaetos*), red-tailed hawks (*Buteo jamaicensis*), ferruginous hawks (*Buteo regalis*), northern harriers (*Circus hudsonius*), and other raptors during a 10-minute period. Counts were restricted to days with light winds (<19 kph) and little or no precipitation (Luginbuhl et al. 2001). At each survey point, avian predators are counted by visually searching the area with the aid of binoculars and listening for bird calls. The species code and counts were recorded along with the time, weather, behavior (flying or perched), and estimated distance at time of first detection. To mitigate double counting, survey points were separated by more than 5 km and previously recorded birds will be tracked prior to moving to the next survey point. The survey routes were located both near and far from lek sites across the SGMA. Using a modification of the method created by Somershoe et al. (2006), we will use distance annuli between <100 and >500 meters from the survey point to estimate density of the avian predator species when combined with the point count data. These distance annuli reflect the open sagebrush habitats and relative ease of detecting larger avian predator species.

Mammalian predator surveys

Scat surveys are inexpensive and noninvasive methods that can provide information on relative predator abundance (Shauster et al. 2002, Kamler et al. 2013), patterns and occupancy (Long et al. 2011), and diet (Kitchen et al. 1999, Losinger et al. 2016). To conduct these surveys, we placed 30, 1km transects on two-track and maintained (gravel) roads throughout the SGMA. Scat survey transects were initially cleared of all scat and surveyed every 4 to 7 days beginning in May and continuing to the end of July. Roads were driven on an ATV to maximize detection of scat presence while minimizing time spent on the transects. Similar to the avian predator surveys, transects were 5 km apart. Species identification included red fox (*Vulpes vulpes*), coyote (*Canis latrans*), American badger (*Taxidea taxis*), and other mammalian predators.

Off-Highway Vehicle Surveys

In 2018, we received funding from the Yamaha Outdoor Access Initiative to initiate a needs assessment of recreational users in the Sheeprock SGMA. We collaborated with researchers, Dr. Jordan Smith and Ben Muhlestein, to develop and implement these surveys during high, medium, and low use days during the summer of 2018, 2019, and 2020 from May to September (Smith et al. 2018). Willing participants were asked to participate in a short questionnaire and, if they agreed, a Garmin GPS device was attached to their OHV to register use of the area. The study will assess recreationalists' use based on motivations gathered from the survey as well as assess impact on habitat fragmentation.

Preliminary Results

Translocations and resident sage-grouse captures

We continued with translocations in 2019, making this the fourth year of the Sheeprock SGMA translocations. Due to access issues caused by the heavy snowfall in 2018-2019, the translocations were delayed. We completed the Parker Mountain translocations on April 24th and 5th, attempted to capture birds in Park Valley on April 29th, with no success, then captured one more night in Parker Mountain on May 2nd. We captured 26 grouse, 16 females and 10 males for the 2019 translocations, 14 fewer than our goal of 40 birds (30 females and 10 males). This was the first year of the four translocation years that we have not been able to capture and translocate 40 grouse.

Table 1. Translocation dates, locations, and total males and female greater sage-grouse (Centrocercus urophasianus) caught per night, Sheeprock Sage-Grouse Management Area, Utah, 2019.

Source Population	Date	Males Captured	Females Captured
Parker Mountain	4/24/2019	9	6
Parker Mountain	4/25/2019	0	6
Park Valley	4/29/2019	0	0
Parker Mountain	5/2/2019	1	4
	Total per M/F	10	16
		Total Translocated	26

We captured and radio-marked 10 Sheeprock birds: two males and eight females. One male, caught on the Fredrickson lek had a leg band upon capture but no transmitter. In retrieving his data from the leg band, we found that he was a 2018 translocated male whose collar had fallen off after our monitoring season last year.

We also captured two birds on Tintic leks: a male on Copperopolis and a female on Furner Valley.

Lek Surveys

In addition to delaying translocations, the increased snow delayed access to the Sheeprock leks as well. Thus, lek counts appeared to decrease, but this count was dependent upon the timing of access. This year, the highest count was in late April and was found to be 32 across all four leks in the SGMA.

In the 2018 annual report, we noted that the locations of lekking males varied for the Benmore lek. This year, we found that to be true again for Benmore as well as Fredrickson. Male lek locations varied for McIntyre as well, but not for Government, which is our largest lek. We emphasize that lek sites are chosen by males based on the proximity to nesting habitat as well as areas through which females travel from wintering habitat to breeding habitat (Gibson 1996).

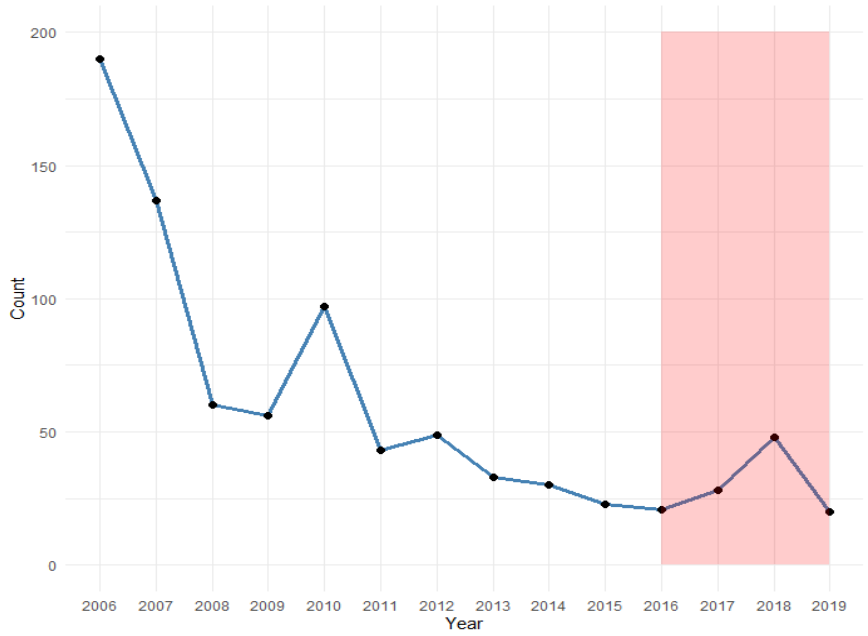

Figure 6. Lek counts from 2006-2019 of greater sage-grouse (Centrocercus urophasianus) located in the Sheeprock Sage-Grouse Management Area (SGMA), Utah, 2019. Counts inside the red shaded area are during the years of translocations. The 2019 counts were biased towards the late season past the peak male lek attendance due to access issues caused by increased snowfall, Sheeprock SGMA, UT.

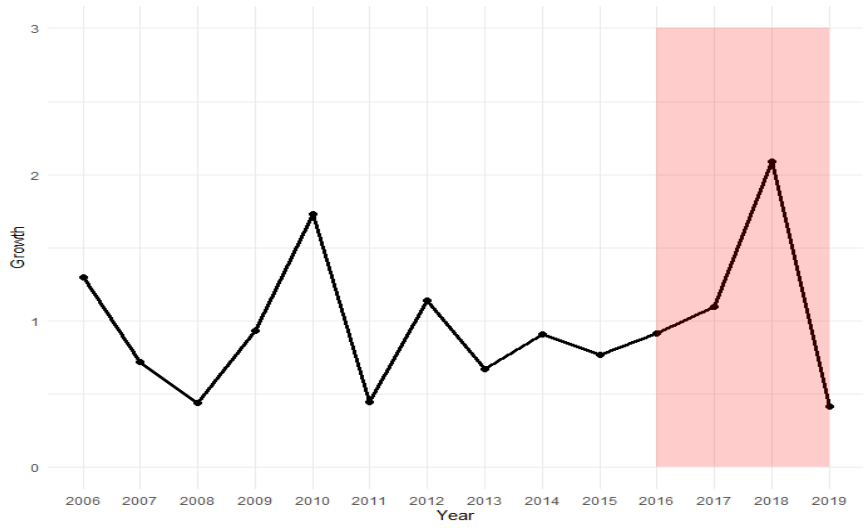

Figure 7. Population growth rates from 2006-2019 of greater sage-grouse (Centrocercus urophasianus) located in the Sheeprock Sage-Grouse Management Area (SGMA), Utah, 2019. A rate above one indicates an increasing population and below one indicates a decreasing population. Counts inside the red shaded area are during the years of translocations. The 2019 rates were biased towards the late season due to access issues caused by increased snowpack.

Monitoring

In 2019, translocation efforts combined with trapping efforts in the Sheeprock SGMA resulted in 36 birds being radio-marked: 26 translocated and 10 resident birds (10 translocated males, 16 translocated females, 2 resident males, 8 resident females). As of 2019, there have been 176 individuals (146 translocated and 30 resident) marked and monitored in the Sheeprock SGMA. As with previous years, we observed individuals exhibiting large movements post-release.

Table 2. Status of greater sage-grouse (*Centrocercus urophasianus*) radio-marked from 2016-2019 in the Sheeprock Sage-Grouse Management Area, Utah, 2019. Undetected individuals have either emigrated from the study area, had collars detach, malfunction, or deplete their batteries.

Year Marked	Mortality in 2019	Mortality from Previous YR	Undetected	Currently Monitoring	Total Marked
2016	1	22	23	1	47
2017	6	26	10	3	45
2018	15	17	6	10	48
2019	15	--	4	17	36
Total	37	65	43	31	176

For the winter locations, we observed birds utilizing areas that we had not yet captured with our GPS data. Below are maps showing locations for October 2018-February 2019:

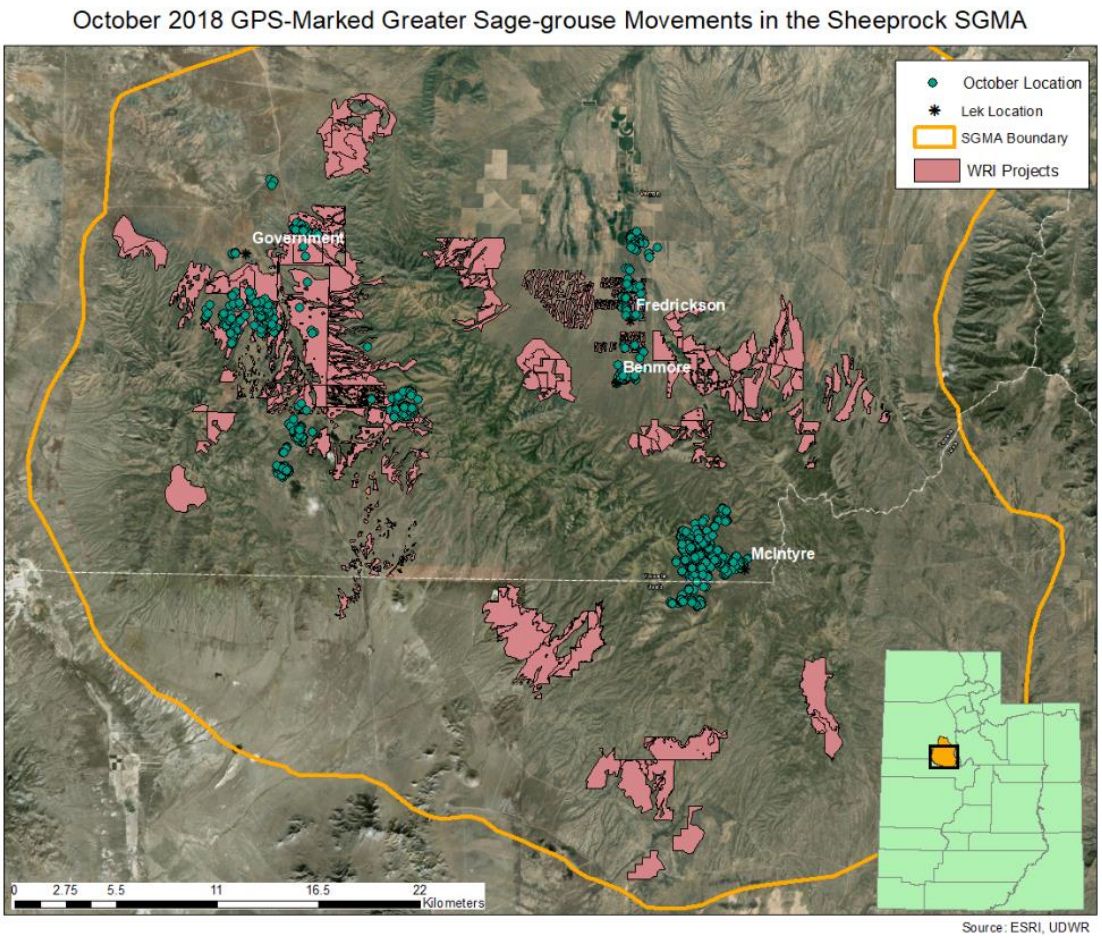

Figure 8. Locations of global positioning system (GPS)-marked greater sage-grouse (Centrocercus urophasianus) in October 2018 with the Watershed Restoration Initiative (WRI) completed habitat restoration projects, Sheeprock Sage-Grouse Management Area, Utah, 2019.

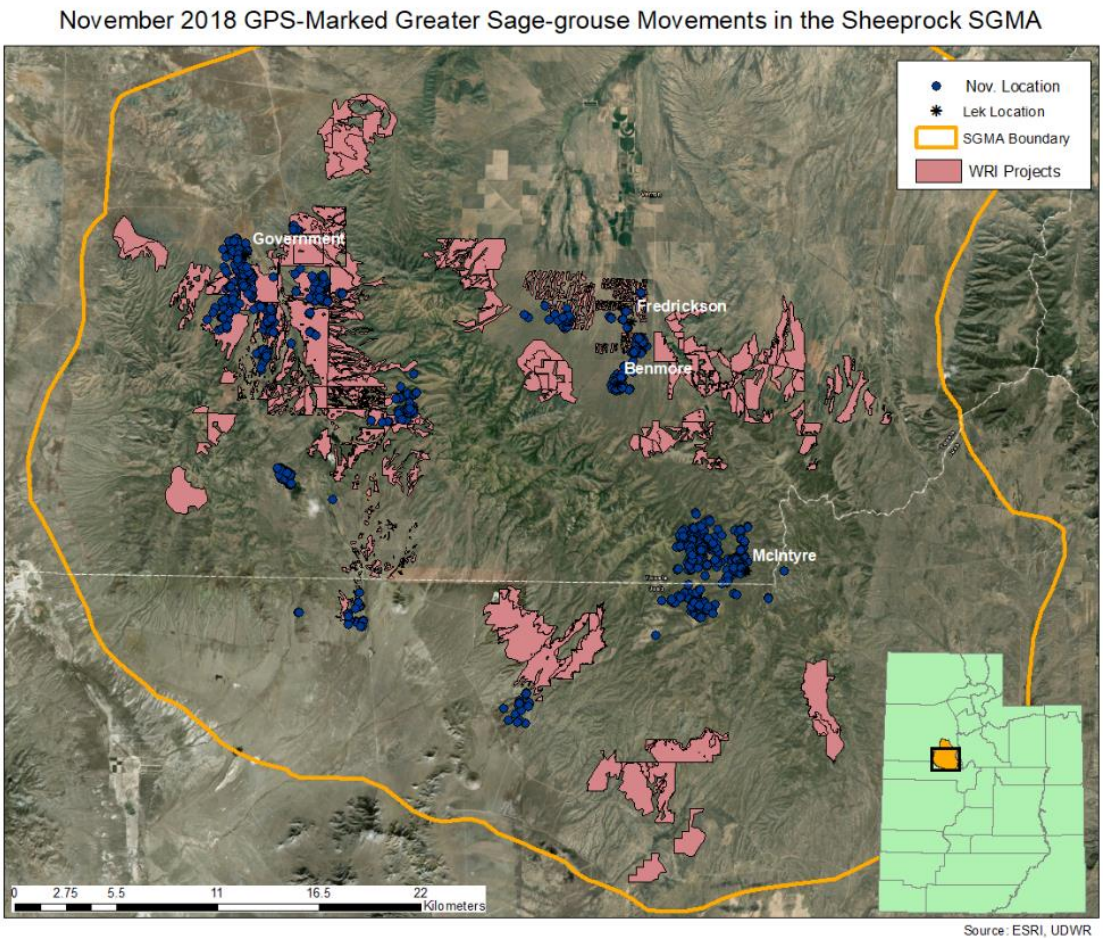

Figure 9. Locations of global positioning system (GPS)-marked greater sage-grouse (Centrocercus urophasianus) in November 2018 with the Watershed Restoration Initiative (WRI) completed habitat restoration projects, Sheeprock Sage-Grouse Management Area, Utah, 2019.

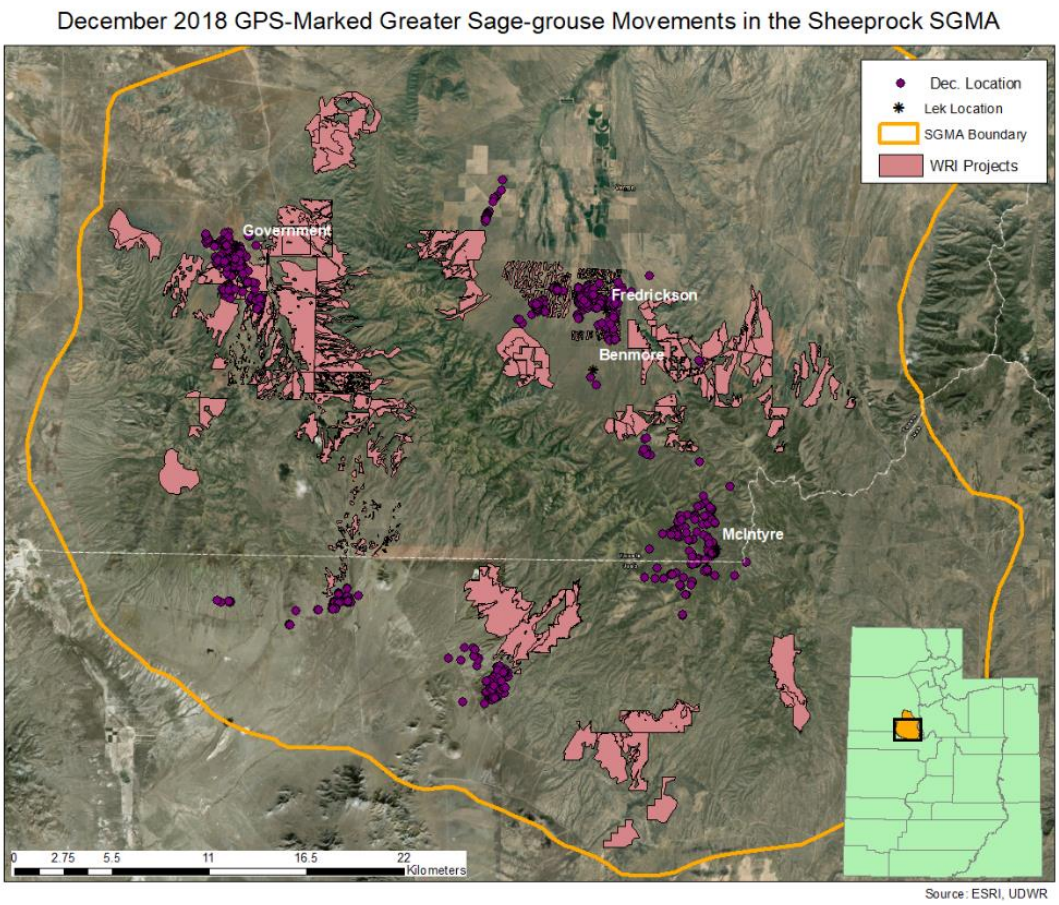

Figure 10. Locations of global positioning system (GPS)-marked greater sage-grouse (Centrocercus urophasianus) in December 2018 with the Watershed Restoration Initiative (WRI) completed habitat restoration projects, Sheeprock Sage-Grouse Management Area, Utah, 2019.

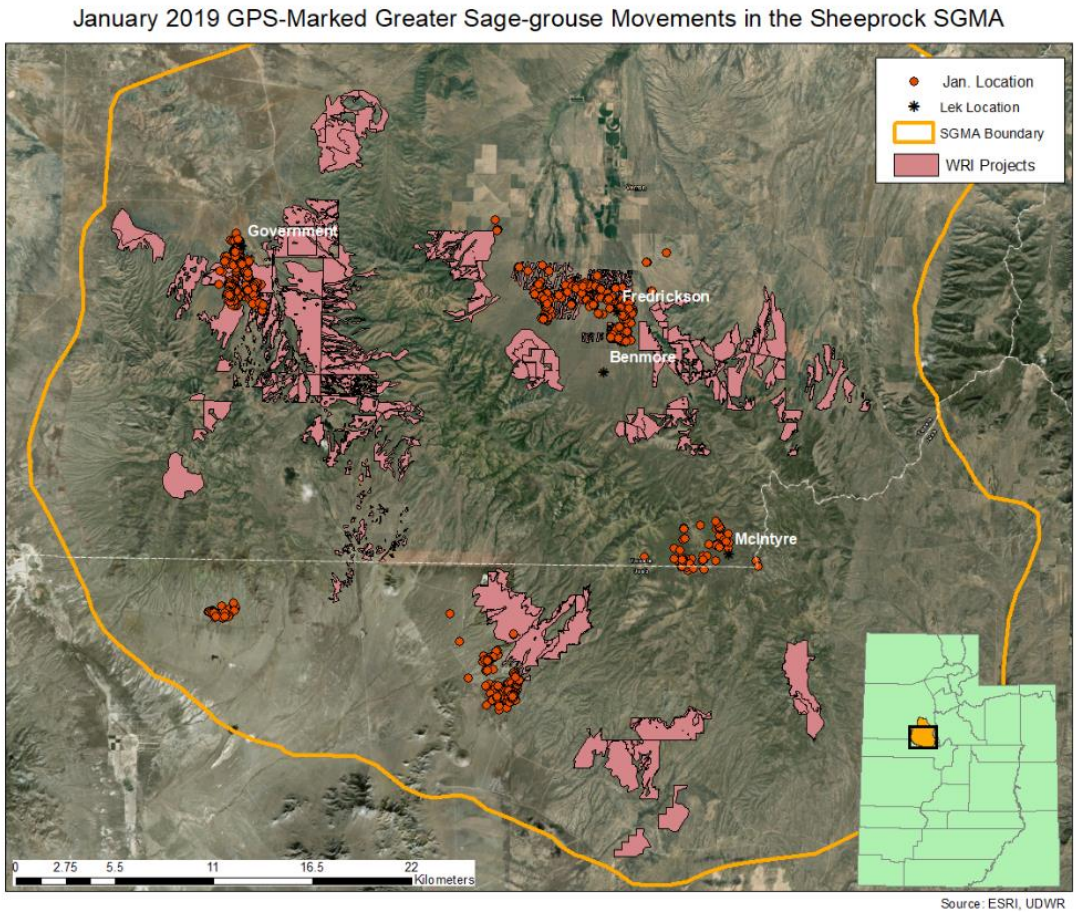

Figure 11. Locations of global positioning system (GPS)-marked greater sage-grouse (Centrocercus urophasianus) in January 2019 with the Watershed Restoration Initiative (WRI) completed habitat restoration projects, Sheeprock Sage-Grouse Management Area, Utah, 2019.

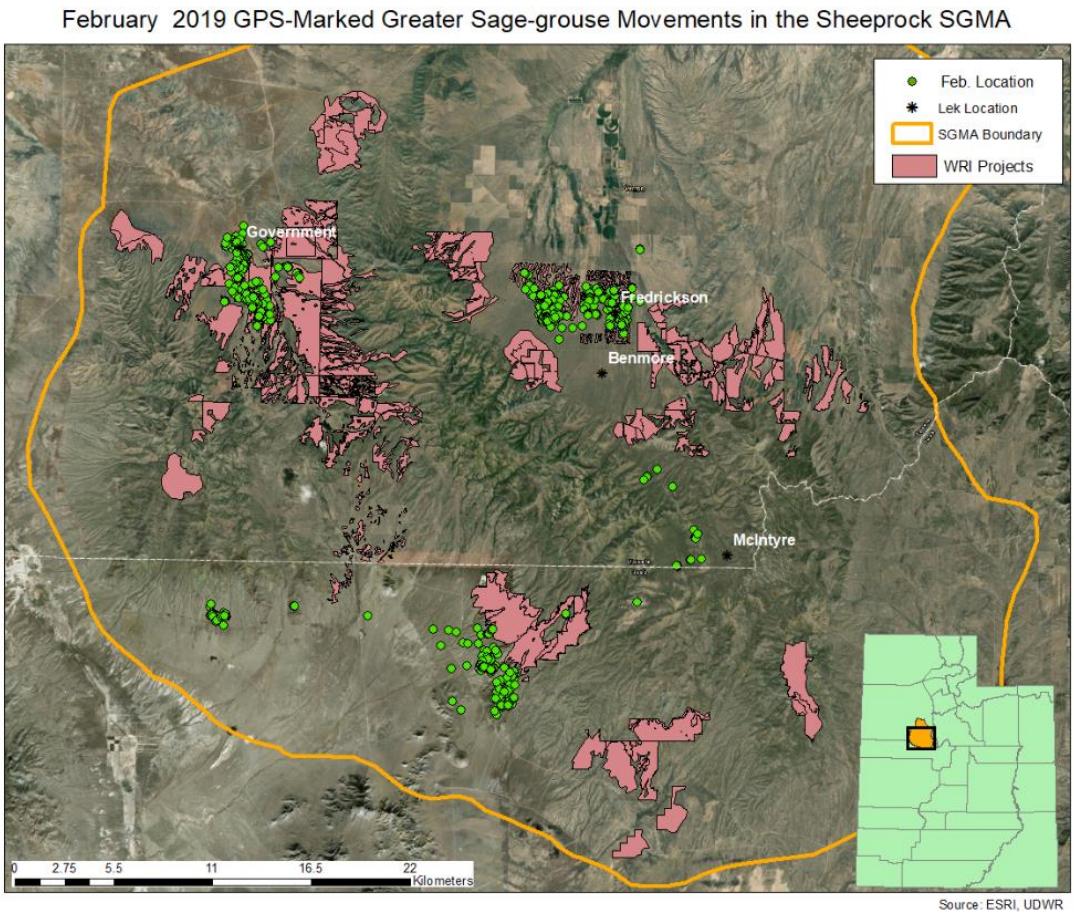

Figure 12. Locations of global positioning system (GPS)-marked greater sage-grouse (Centrocercus urophasianus) in February 2019 with the Watershed Restoration Initiative (WRI) completed habitat restoration projects, Sheeprock Sage-Grouse Management Area, Utah, 2019.

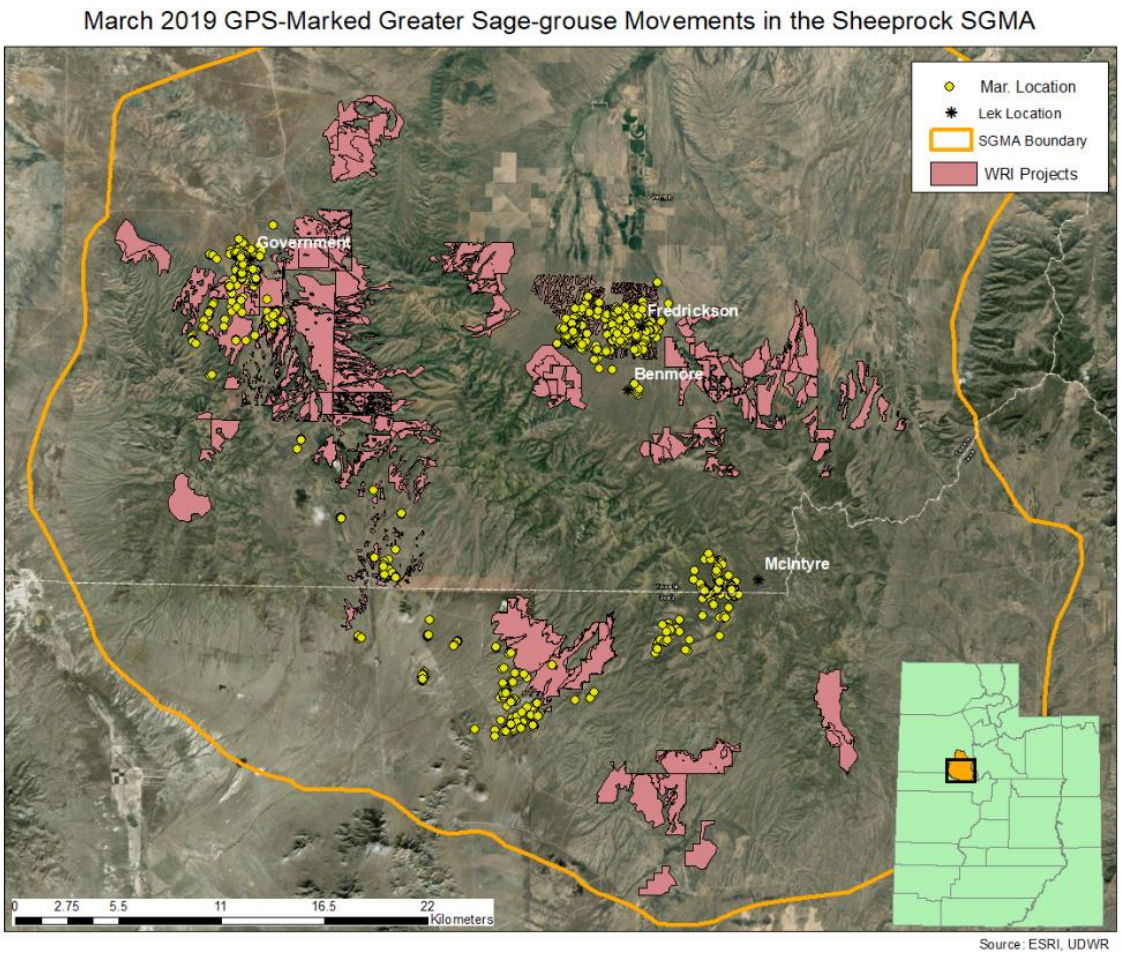

Figure 13. Locations of global positioning system (GPS)-marked greater sage-grouse (Centrocercus urophasianus) in March 2019 with the Watershed Restoration Initiative (WRI) completed habitat restoration projects, Sheeprock Sage-Grouse Management Area, Utah, 2019.

Nest Initiation, Success, and Brooding

Of the 44 radio-marked and live females detected during the 2019 nesting season, 24 nest initiations were detected. This gives an apparent nest initiation rate of 54.55%. The 24 nest initiations were from the following, shown in Table 3. At least 82 chicks successfully hatched from these nests; one GPS female's transmitter stopped transmitting during her nesting period due to lack of sun and could not be found post-hatch. Figures 14-16 shows the nesting locations of all 24 nests in the Sheeprock SGMA and Table 3 summarizes the nesting and brooding results.

Table 3. Nest initiations for translocated and resident greater sage-grouse, by age in 2019, Sheeprock Sage-Grouse Management Area, Utah, 2019.

Year Marked	Number of Females Nesting	Adults/Yearlings	Translocated/Resident
2016	2	2 Adults	2 Res
2017	4	4 Adults	4 Trans
2018	8	8 Adults	7 Trans, 1 Res
2019	10	4 Adults, 6 Yearlings	5 Trans, 5 Res

Of the 24 nests, 17 hatched and 5 broods successfully reached the 50-day mark. The apparent brood success was estimated as 29.4%, lower than 2018's estimated 61.5% and 2017's 40%. Twelve chicks were present from these 5 broods, yielding an apparent chick survival of 14.6%. Figures 14-16 show the brood locations of each brood with their nesting locations. Various studies found chick survival, whether either apparent or estimated, to be: 39% at 28 days post-hatching (Gregg 2006); 44% at 18 days post-hatch in Nevada (Reholz 2007); 34% to 42% in North Dakota and 32%-50% in South Dakota, respectively at 21 days post-hatch (Herman-Brunson 2007, Kaczor 2008); and 50% at 42 days in Utah (Dahlgren et al. 2010).

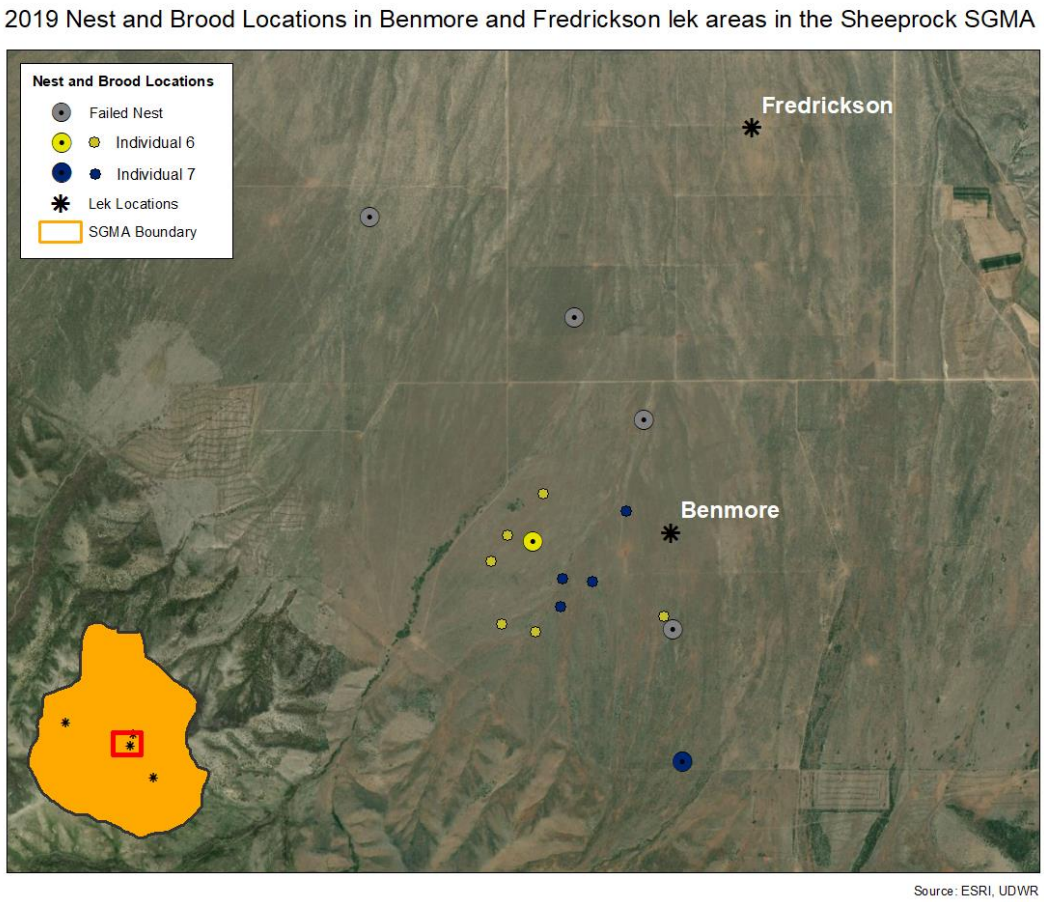

Figure 14. Nesting and brooding locations for marked females located within the Benmore and Fredrickson lek areas, Sheeprock Sage-Grouse Management Area, Utah, 2019. Each nest and brood point of the same color correspond to the same female.

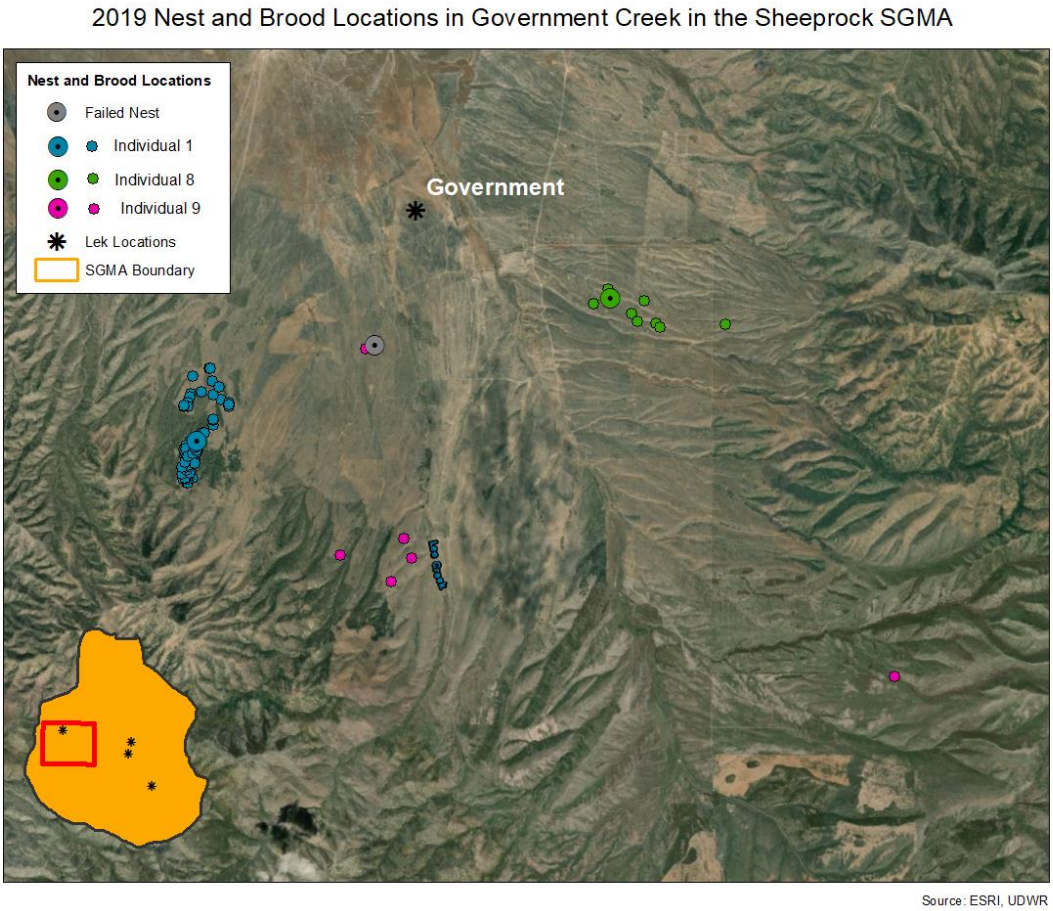

Figure 15. Nesting and brooding locations for marked females located within the Government Creek lek area, Sheeprock Sage-Grouse Management Area, Utah, 2019. Each nest and brood point of the same color correspond to the same female.

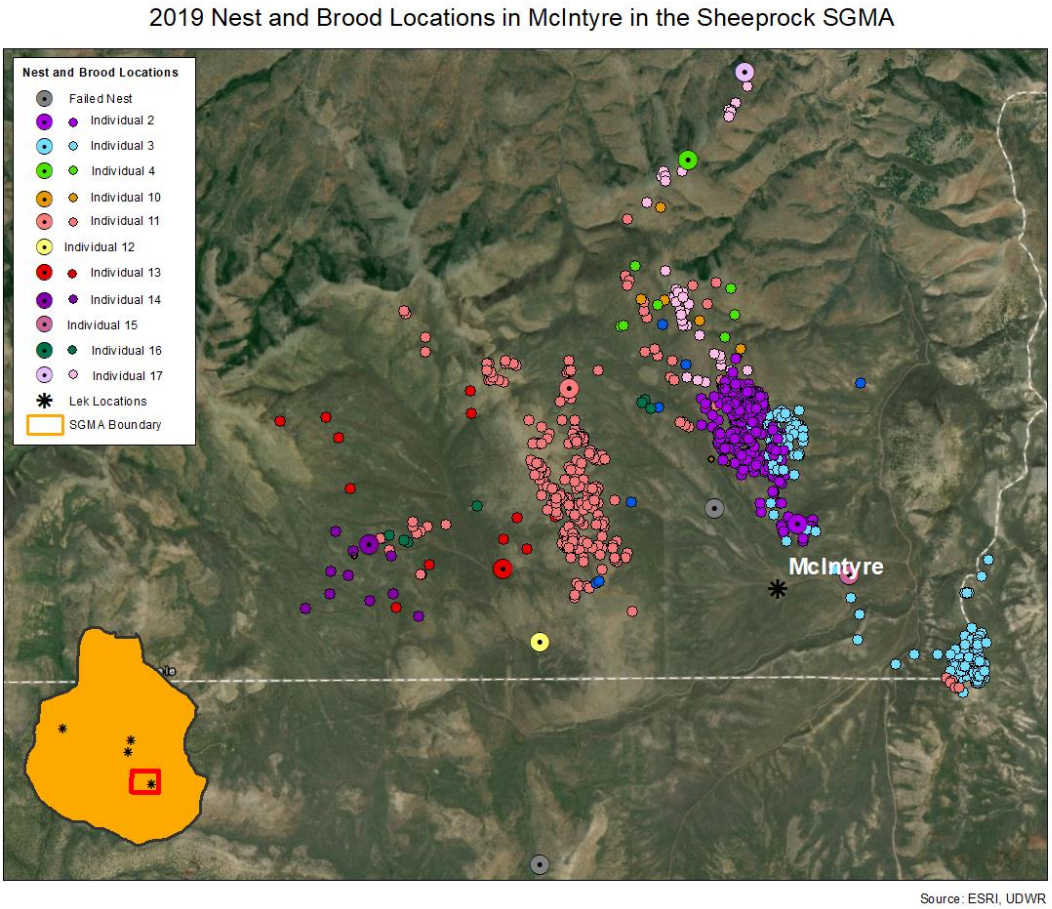

Figure 16. Nesting and brooding locations for marked females located within the McIntyre lek area, Sheeprock Sage-Grouse Management Area, Utah, 2019. Each nest and brood point of the same color correspond to the same female.

In the Government Creek lek area, a resident yearling female sage-grouse captured and marked on the western portion of the lek area nested and brooded among juniper stands, shown on the larger landscape in Figure 15, Individual 1. Though she selected for this habitat, it required substantial energy to brood in, and she lost her chicks and died during the brooding season. Below, in Figure 17, we highlight her nest location as well as her brooding locations. While this does not mean that sage grouse select for conifer-dominated area, it could be an indicator of site fidelity from her natal brood.

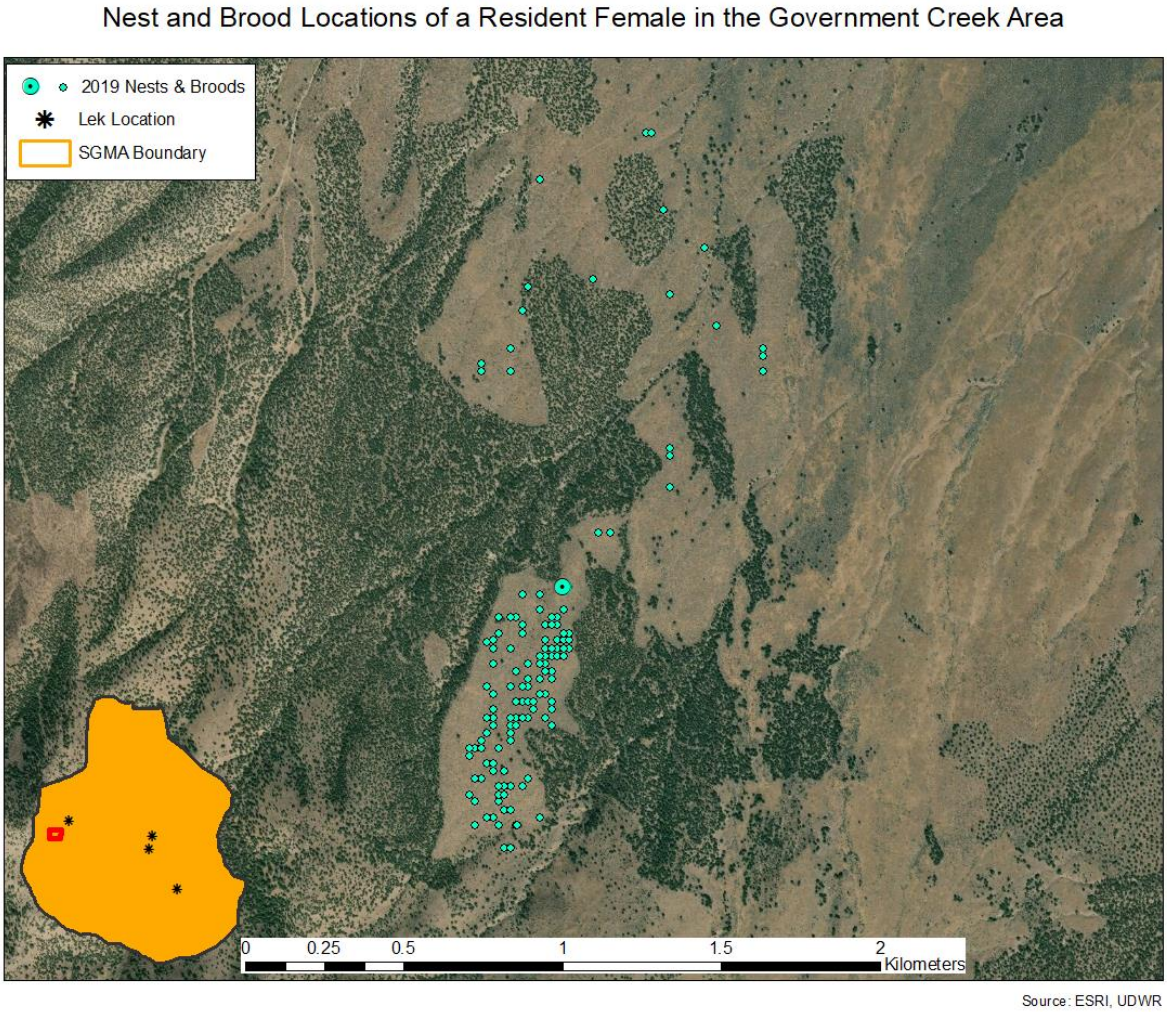

Figure 17. Nest and brood locations for a yearling resident female caught in Government Creek in 2019 that nested and brooded among fragmented sagebrush stands within juniper stands in the Sheeprock Sage-grouse Management Area, Utah, 2019.

Per a request of the WDARM local working group, we have provided maps of all nest and brooding locations acquired from 2016-2019. These maps are included in figures 18-20 below.

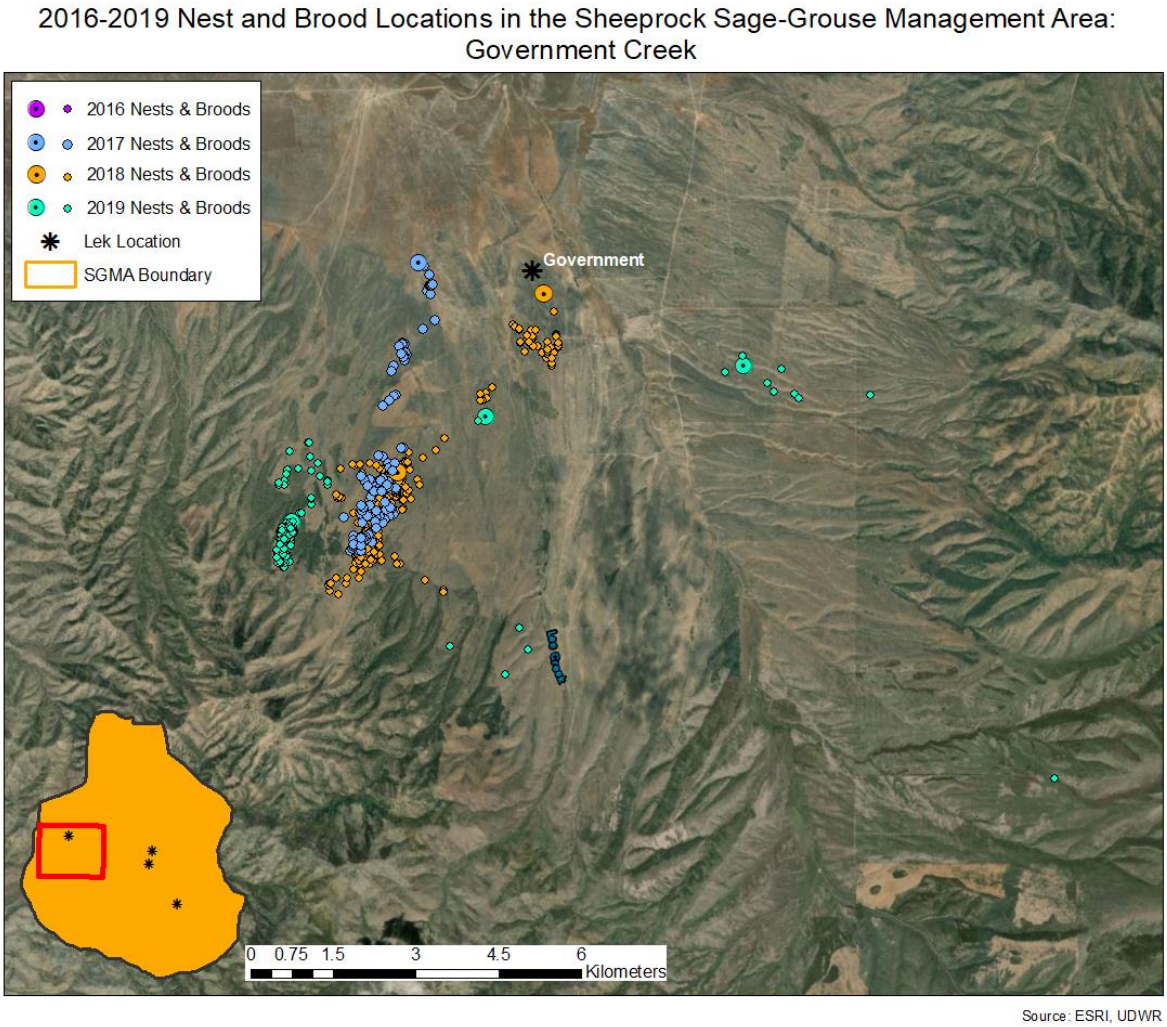

Figure 18. Nesting and brooding locations for marked females located within the Government lek area for 2016-2019, Sheeprock Sage-Grouse Management Area, Utah, 2019. Each nest and brood point of the same color correspond to the same year of locations.

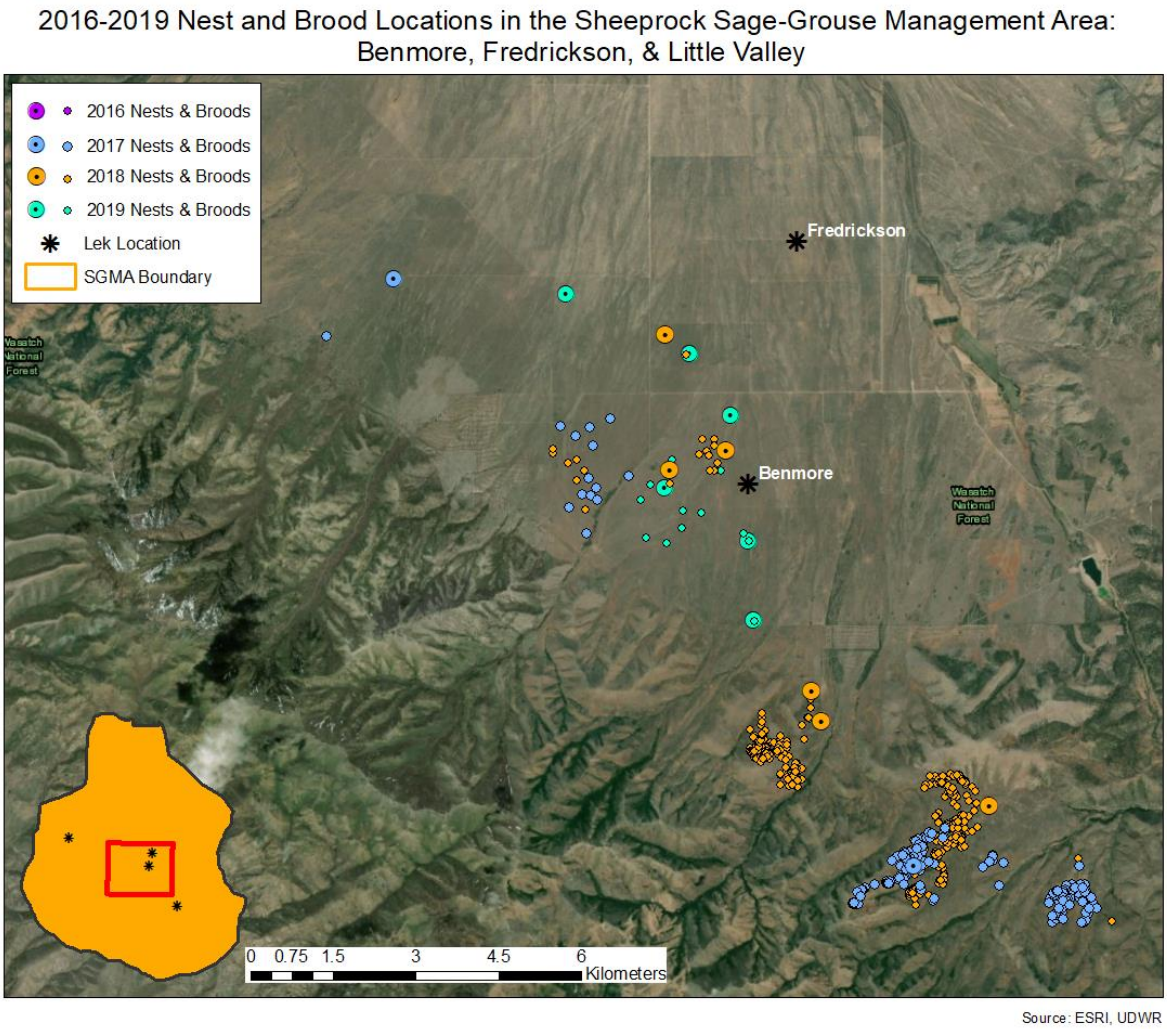

Figure 19. Nesting and brooding locations for marked females located within the Benmore, Fredrickson, and inactive Little Valley lek areas for 2016-2019, Sheeprock Sage-Grouse Management Area, Utah, 2019. Each nest and brood point of the same color correspond to the same year of locations.

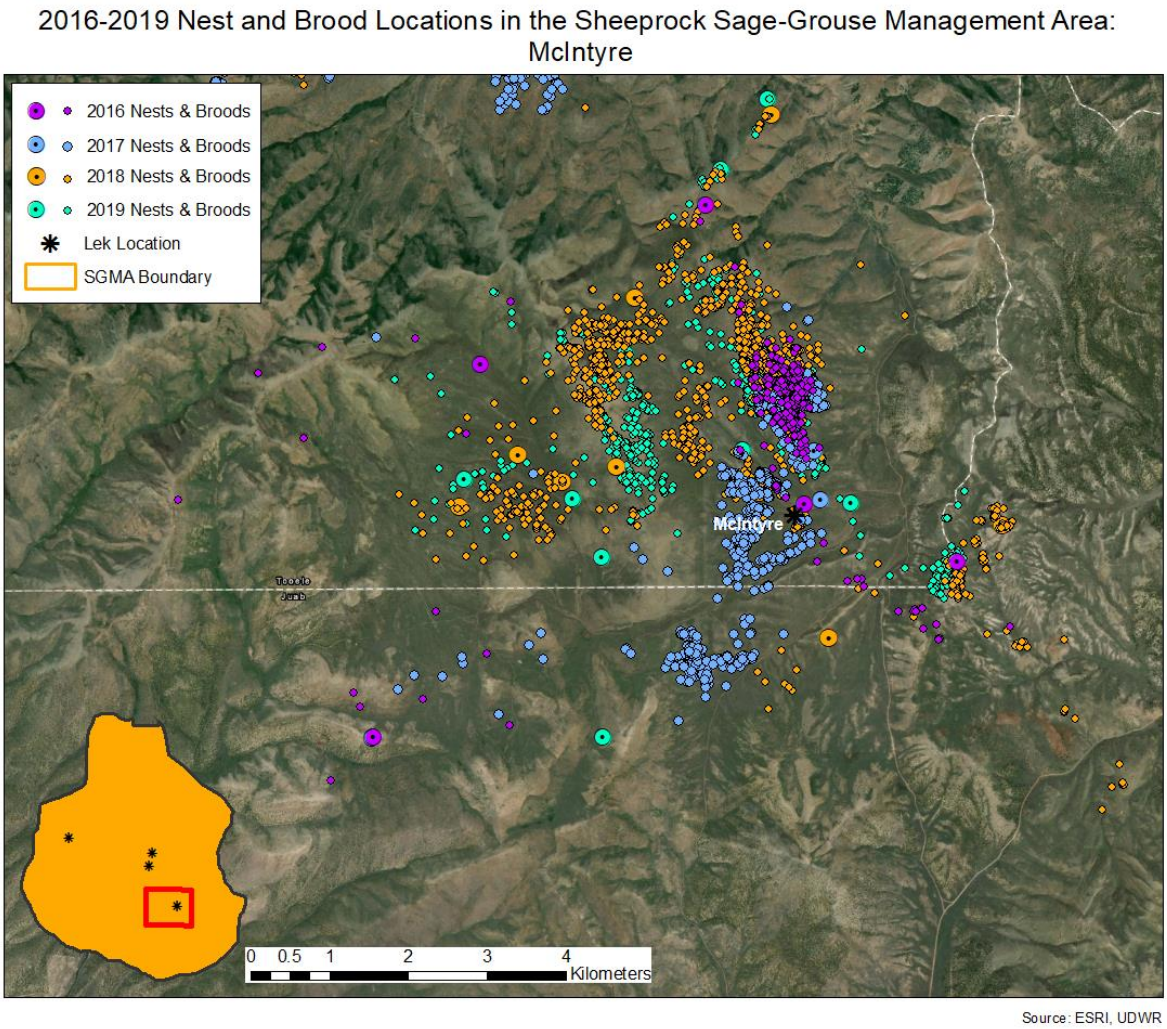

Figure 20. Nesting and brooding locations for marked females located within the McIntyre lek area for 2016-2019, Sheeprock Sage-Grouse Management Area, Utah. Each nest and brood point of the same color correspond to the same year of locations.

Survival

We confirmed 31 mortalities in 2019 (Figure 21). One mortality was from a female marked in 2016. Six mortalities were from birds marked in 2017: 5 translocated females and 1 translocated male. Fifteen were confirmed mortalities from our birds marked in 2018: 7 translocated females, 2 resident females, and 6 translocated males. Nine mortalities were confirmed from individuals marked in 2019: five from translocated females, 2 from resident females, and two from translocated males (Table 4).

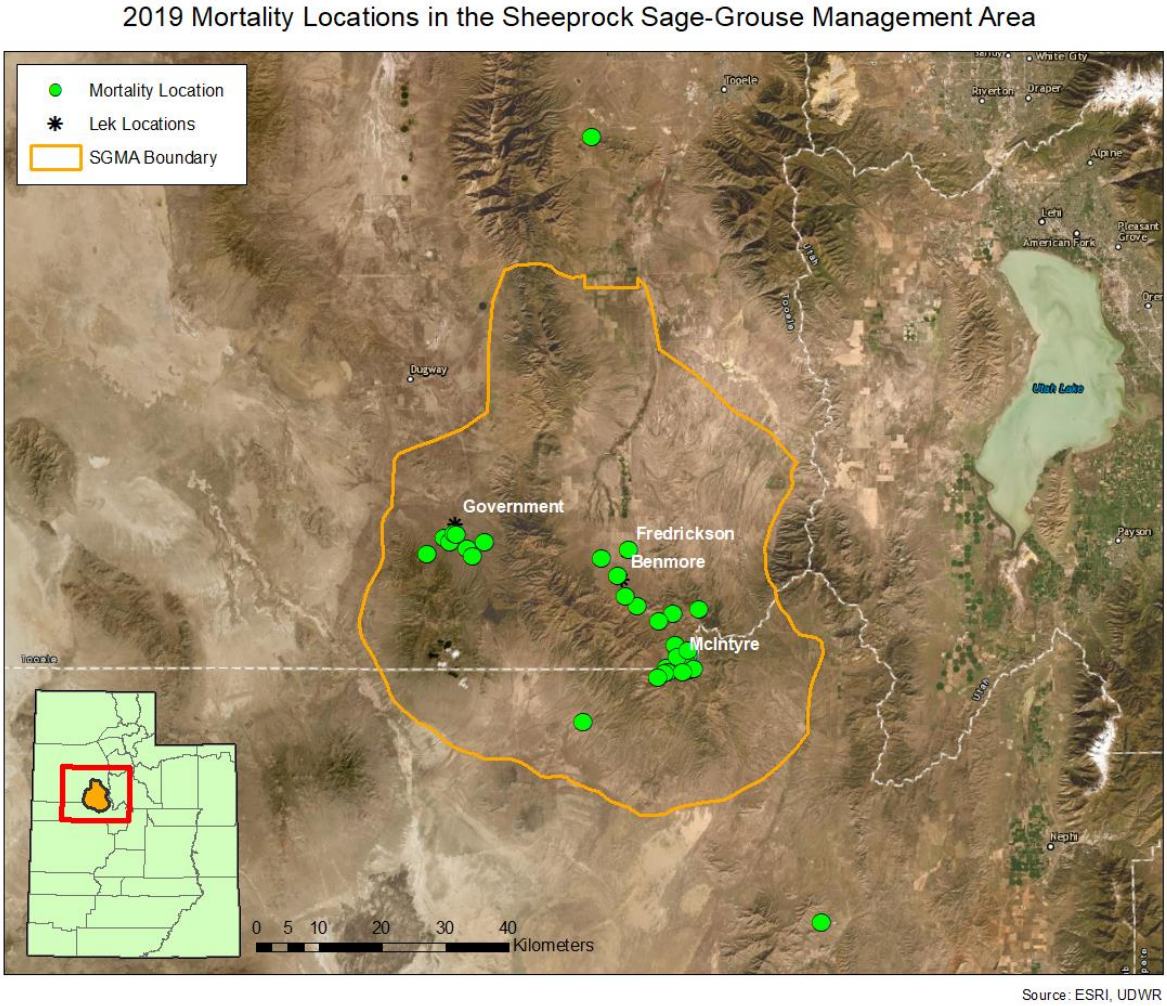

Figure 21. Mortality locations of greater sage-grouse (Centrocercus urophasianus) located within the Sheeprock Sage-Grouse Management Area, Utah, 2019.

We included the path of a sage-grouse translocated and released into the Sheeprock SGMA that travelled north towards Rush Valley, Utah, where it died (Figure 22).

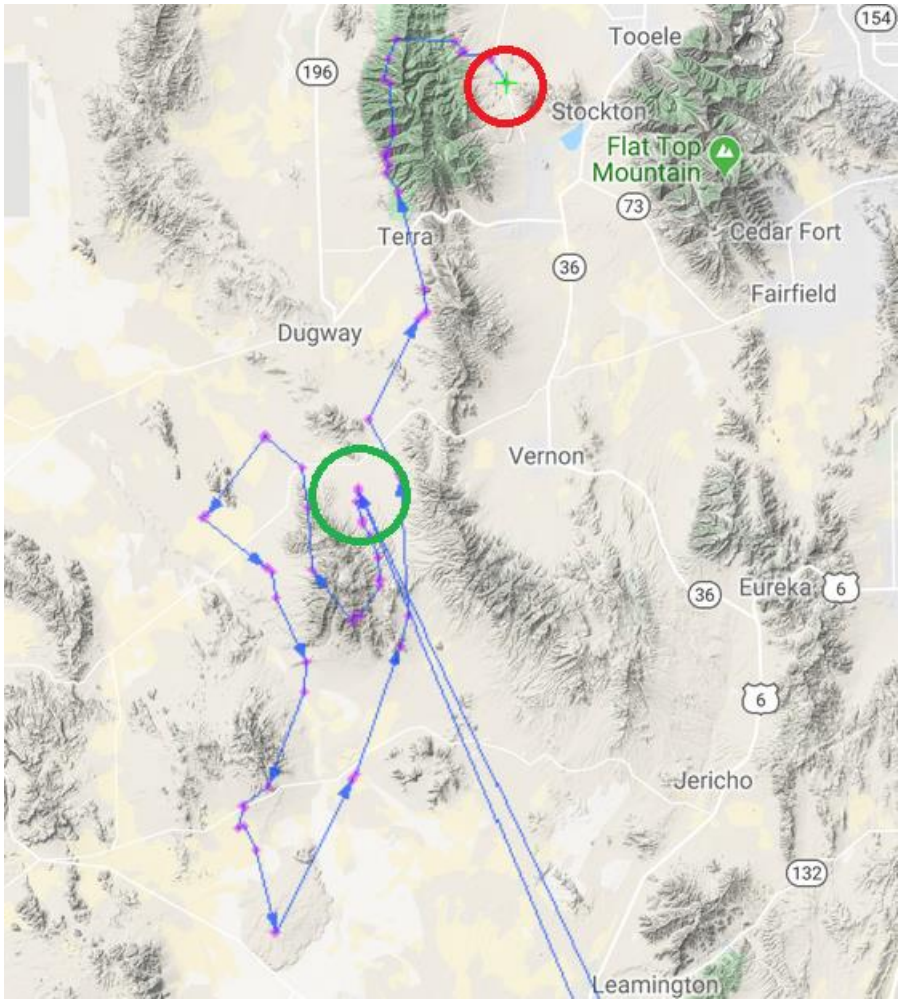

Figure 22. Movements of a yearling female greater sage-grouse translocated from Parker Mnt-Emery Sage-Grouse Management Area (SGMA) and released into Government Creek in the Sheeprock SGMA, Utah, 2019. The green circle is the release site, the blue arrows indicate directional movements, and the red circle is the mortality site.

Table 4. A breakdown of the mortalities during 2019 by sex, translocated or resident, and the year marked in the project, Sheeprock Sage-Grouse Management Area, Utah, 2019.

Year Marked	Mortalities in 2019	Male/Female	Translocated/Resident
2016	1	1 Female	1 Res
2017	6	5 Female, 1 Male	6 Trans
2018	15	9 Female, 6 Male	13 Trans, 2 Res
2019	15	12 Female, 3 Male	11 Trans, 4 Res
Total Mortalities	37		

Using a Cox Proportional Hazard model (Cox 1972), we have compared the monthly survival across years for all birds monitored from 2016 to 2019. Figure 23 illustrates the survival probabilities for 2016, 2017, 2018, and 2019.

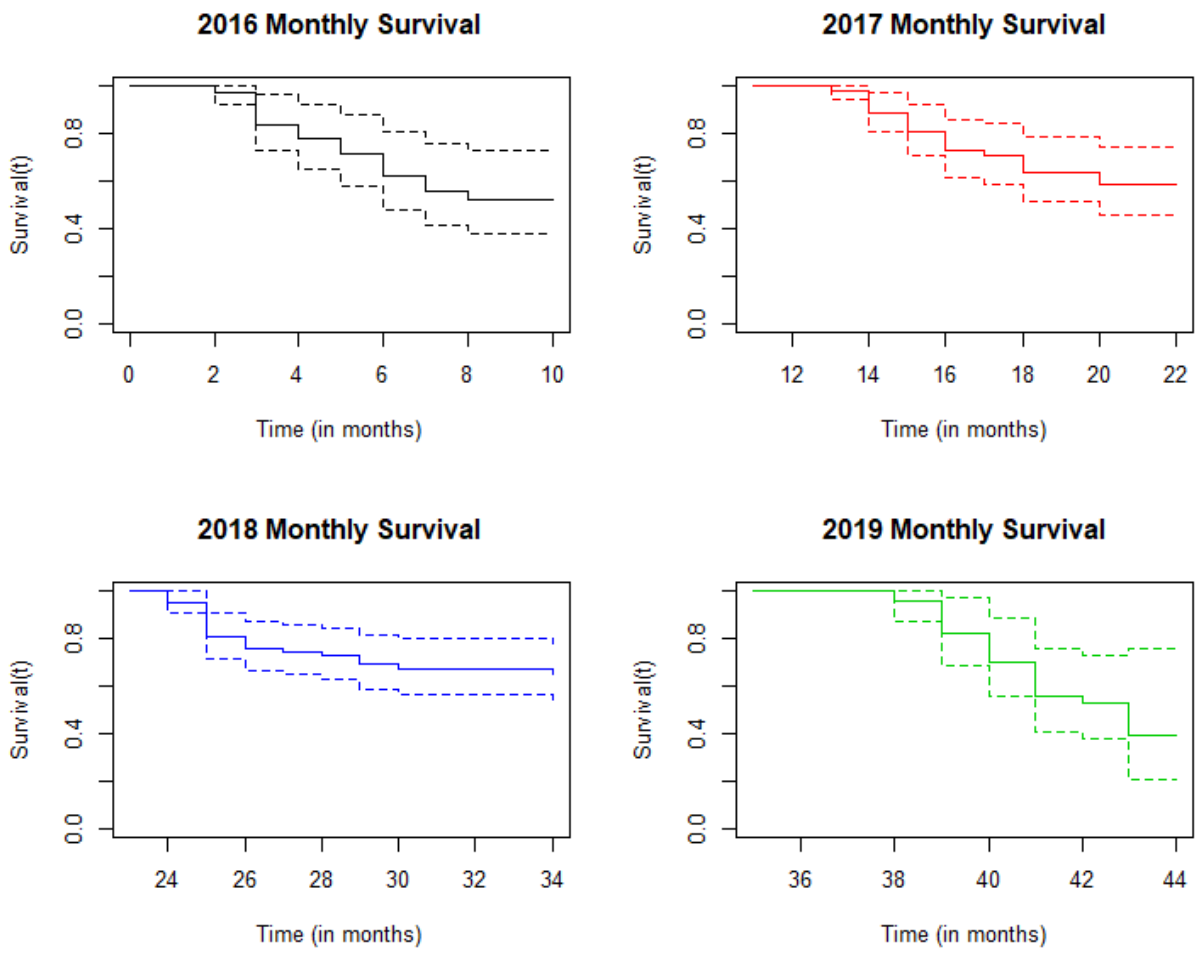

Figure 23. Cox Proportional Hazard models of monthly survival for greater sage-grouse (Centrocercus urophasianus) marked in 2016-2019 in the Sheeprock Sage-Grouse Management Area, Utah, 2019.

Predator Surveys

We included preliminary data the total individuals we observed per species on our avian and mammalian surveys for 2017, 2018, and 2019. Figure 16 illustrates the overall raw counts of predators in the study area from May through July. In addition to our predator surveys, we also have provided the estimated predator take numbers provided by the USDA-APHIS Wildlife Services from 2019. Though it appears that most predators increased, and some increased significantly, we do not recommend increased predator removal efforts based on these data. These counts are preliminary and may be a result of yearly variation, such as increased precipitation, different technicians ‘abilities, etc.

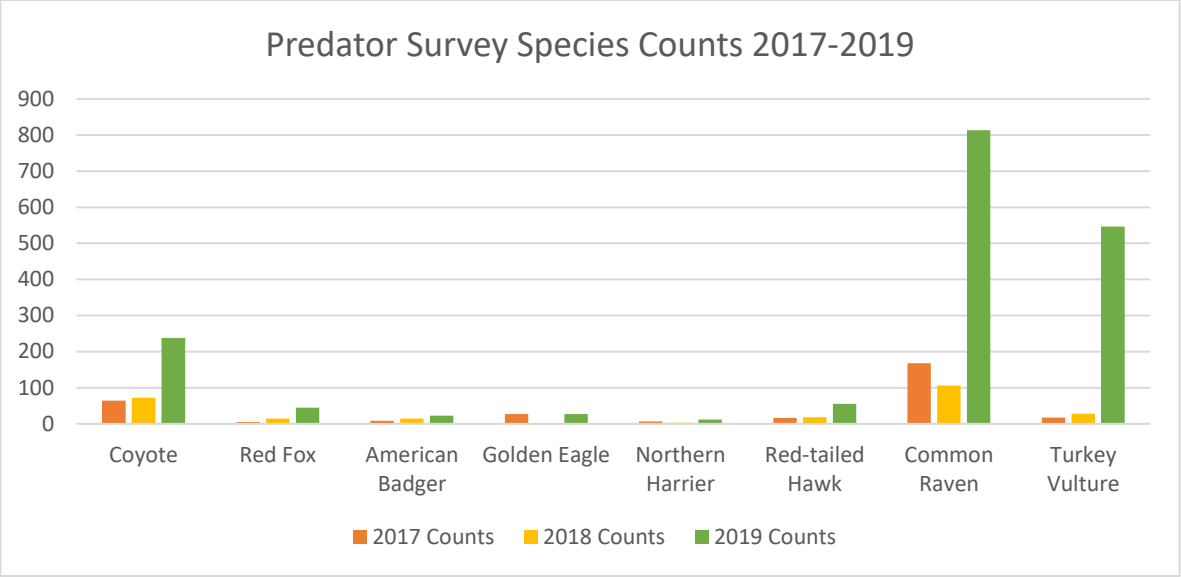

Figure 24. Data gathered from the predator surveys performed in May through July of 2017, 2018, and 2019 in the Sheeprock Sage-grouse Management Area, Utah, 2019.

Table 5. Estimated number of predators taken through June of 2018 in the Sheeprock Sage-Grouse Management Area by species as reported by USDA-APHIS Wildlife Services, Sheeprock SGMA, Utah, 2019.

2019 USDA-APHIS Wildlife Services Sheeprock SGMA Predator Take Numbers (through June)	
Target Species	**# Estimated Individuals Taken**
Common Raven (*Corvus corax*)	303
Coyote (*Canis latrans*)	86
Red Fox (*Vulpes vulpes*)	1
Raccoon (*Procyon lotor*)	0

2020 Work Plan

Jan-March: Field preparations to include finalizing research-funding plan, hiring technicians, purchasing radio-transmitters and field equipment, and participation in local working group and related meetings.

March-May: Sage-grouse capturing, radio-marking, and participation in local working group and related meetings. We will be hiring four technicians this field season. More effort will be put into trapping in Government Creek and Fredrickson Pastures to acquire better data of resident birds' movements. Predator surveys will also be conducted during the field season to estimate predator abundance.

May-August: Monitoring radio-marked sage-grouse vital rates and habitat-use, predator surveys, and participation in local working group and related meetings. In order to better estimate chick survival during the brooding season, we will employ the use of pointing dogs to detect females

with their chicks for their 50-day brooding surveys. Dahlgren et al. (2010) found that spotlight and pointing-dog surveys detected 96% of chicks that were marked in the study, and found no significant difference between the use of pointing-dogs and spotlight surveys.

August- December: Monthly monitoring of population, data analysis and reporting, and participation in local working group and related meetings.

Acknowledgements

As always, we thank the landowners who allow us access to their properties to capture and monitor birds. We also are extremely indebted to the dozens of volunteers who have helped with the translocation effort. We particularly thank Jason Robinson and Avery Cook, UDWR for coordinating the effort through the public review process and the logistics required to complete the translocation. We also thank the Utah Public Lands Policy Coordination Office, the BLM, the Yamaha Corporation, the West Box Elder CRM, the Parker Mountain and West Desert Adaptive Resources Management Local Working Groups, the Jack H. Berryman Institute, the Quinney Professorship for Wildlife Conflict Management, the UDWR, and the US Geological Service for funding, encouragement, and project support.

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